Distribution and habitat of the flute-nosed bat *Murina florium* (Chiroptera: Vespertilionidae) in the wet tropics of north-eastern Queensland

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ABSTRACT

The flute-nosed bat *Murina florium* is a poorly known species that was first discovered in Australia at Mt Baldy State Forest on the Atherton Tablelands in north-eastern Queensland in 1981. Subsequently there have been few other documented records despite intensive harp trapping studies, with the species only recorded from an additional six localities up until December 1995. This study provides four new locality records for the species, including two records which extend the known southern range limits of *M. florium* by 150 km across the Herbert River discontinuity within the Wet Tropics bioregion. The broad habitat characteristics of all known localities for the species are reviewed and the paper presents the first account of this bat occurring in non-rainforest habitat. Occurrence of *M. florium* in this habitat is discussed using current knowledge of roosting and ecomorphology characteristics. A predicted distribution of *M. florium* based on the 11 locality records, is calculated using DOMAIN and 16 biophysical parameters.

Key words: *Murina florium*, distribution, habitat, Wet Tropics, DOMAIN, rainforest, Chiroptera

INTRODUCTION

The genus *Murina* comprises 14 species that are characterized by distinctive laterally diverging nostrils, somewhat resembling those of *Nyctimene* or *Paranyctimene* in the Pteropodidae (Nowak 1994). The ecology of species within *Murina* is poorly known with no detailed studies published and the majority of available information documented as anecdotal observations (e.g. Payne *et al.* 1985; Flannery 1995a). The only species within the genus recorded in Australia is the flute-nosed bat (after Churchill 1998) or tube-nosed insectivorous bat *Murina florium*, although a single adult male collected at Iron Range (12040'S, 143020'E), Cape York Peninsula on 6 October 1983 may represent a second species (Van Dyck 1991; Richards *et al.* 1995). *Murina florium* is known from less than 80 specimens in scattered localities from south-west Indonesia to Papua New Guinea and north-eastern Australia (Wilson and Reeder 1993; Flannery 1995a, b; Schulz and Hannah 1996, 1998). The first Australian record of this bat was in August 1981 when a single female was captured in Mt Baldy State Forest (17017'S, 145025'E) on the Atherton Tablelands, north-eastern Queensland (Richards *et al.* 1982). This individual was located at an elevation of approximately 1300 m in simple microphyll vine-fern forest. The single record of this bat in Australia up until 1982 prompted Richards (1983) to suggest that this species was the "rarest mammal recorded alive in Australia".

The second confirmed record of the species was five years later in October 1986, when four individuals were captured in Mt Hypipamee National Park on the Atherton Tablelands (G. Hoye, unpublished record). Similar to the initial record, these individuals were captured in upland rainforest at an elevation of 1080 m, leading to suggestions that the species was confined to upland rainforest in Australia (Winter 1991). Subsequently, despite extensive harp trapping and mist-netting studies in north-eastern Queensland (e.g. Crome and Richards 1988) this bat was only recorded from four additional localities within and immediately adjacent to the Wet Tropics bioregion of north-eastern Queensland up until 1994, ranging from 260 to 640 m in elevation. Single individuals were recorded from Shipton's Flat, south of Cooktown (15048'S, 145014'E), Cedar Bay National Park (15048'S, 145015'E), and Lamb Range State Forest (16059'S, 145037'E) (Spencer *et al.* 1992; Kutt and Burnett 1995). Between 1994 and 1996 multiple individuals were captured at two sites in the Wet Tropics bioregion as a result of intensive harp trapping. Thirty individuals were captured in the Walsh River headwaters at Mt Baldy State Forest in four sampling periods (December 1994 and 1995, April 1996 and June 1996). In addition, four individuals were captured on a single night in this area in December 1998 (M. Schulz and L. Hogan, unpublished records). In the second site, eight individuals were trapped adjacent to Koombooloomba Creek in Koombooloomba State Forest, south of Ravenshoe (17051'S, 145035'E) in two sample periods (December 1994 and 1995) (Schulz and Hannah 1996, 1998).

This paper presents new localities for M. *florium* in the Wet Tropics bioregion, investigates broad habitat characteristics at all known capture sites, and provides a predicted bioclimatic distribution within the Wet Tropics using DOMAIN analysis based on known records.

MATERIALS AND METHODS

New Localities and Habitat Characteristics

New site localities for M. *florium* were obtained by the authors, either while conducting field work for an ecological study of the golden-tipped

Table 1. Vegetation information for known M. florium localities in the Wet Tropics bioregion, Australia. * - Webb 1982. ** - Multiple records within 1 km radius with all records from the same vegetation type. Sources: 1 – Richards et al. 1982; 2 – G. Hoye unpublished records; 3 – N. Schedvin pers. comm.; 4 – Spencer et al. 1992; 5 - Kutt and Burnett 1995; 6 – Schulz and Hannah 1996; 7 – Schulz and Hannah 1998; 8 – A. Kutt, unpublished records; 9 – M. Schulz, unpublished records; and 10 – Schulz and Hogan 1999a.

Site No.	Locality	Grid Reference	Altitude (m)	Vegetation Type*	Within 100m of Ecotone	Source
1	Mt Baldy State Forest	17017'S 145025'E	1300	Type 9 simple microphyll vine-fern forest	-	1
2	Mt Hypipamee National Park	17025'S 145029'E	1080	Type 9 simple microphyll vine-fern forest and Type 5a complex notophyll vine forest	-	2
3	Shipton's Flat	15048'S 145014'E	271	Type 5b complex notophyll vine forest	Type 16a medium open forest with E. tessellaris	3, 4
4	Cedar Bay National Park	15048'S 145015'E	260	Gallery forest	-	3, 4
5	Lamb Range State Forest	16059'S 145037'E	640	Type 2a mesophyll vine forest, with fringing Type 13c vine forest	-	5
6**	Walsh River, Mt Baldy State Forest	17017'S 145025'E	1100	Type 9 simple microphyll vine-fern forest	-	6, 7
7**	Koombooloomba State Forest	17051'S 145035'E	810	Type 8 simple notophyll vine forest, some Type 14c tall open forest with a notophyll vine forest understorey	-	6, 7
8	Wallaman Falls National Park	18036'S 145048'E	640	Type 8 simple notophyll vine forest	14a tall open-forest and 16e medium woodland	8
9	Sandy Creek, Mt Carbine Tablelands	16028'S 145012'E	1130	Type 2a mesophyll vine forest	Type 14c tall open forest	9
10	Boundary of Mt Zero Holding and Mt Spec State Forest Paluma Range	19002'S, 146008'E	875	Type 14c tall open forest with a notophyll vine forest understorey	Type 14c tall open forest	10
11	Clarke Creek, Mt Zero Holding, Paluma Range	19001'S, 146008'E	880	Type 14c tall open forest lacking a rainforest understorey	-	10

bat *Kerivoula papuensis* (M.S.) or while conducting fauna survey work (A.K. and M.S.) within the Wet Tropics bioregion between December 1995 and December 1998. The broad habitat characteristics of capture sites were examined incorporating both the new site localities and records obtained prior to December 1995 (table 1). Vegetation type at all sites was classified following the system of Webb (1978) and Tracey (1982).

Predicted Distribution

All records of M. *florium* in the Wet Tropics bioregion were analysed from selected biophysical attributes using DOMAIN. This procedure creates a range-standardised point-to-point similarity matrix from biophysical parameters to model potential distributions, and is considered a superior method to BIOCLIM in which the derived climatic envelope for the predictive model is based on extreme climatic ranges (for further details see Carpenter *et al.* 1993). However, DOMAIN still utilises climatic parameters and data obtained from the bioclimate prediction system, BIOCLIM (Nix 1986; Hutchinson 1991), as well as incorporating more detailed local data sets (refer to citations in Table 2).

Sixteen biophysical parameters were used in DOMAIN to generate an environmental profile for the M. *florium* point localities within the Wet Tropics bioregion (Table 2). These parameters have previously been used for examination of the distribution of *K. papuensis* (Walton et al. 1992; Parnaby and Mills 1994). The derived output creates a similarity matrix where all candidate areas are assigned a classification confidence, rather than probability estimates. For each parameter the mean, maximum and minimum values from all eleven Wet Tropics records are determined (Table 2), creating an indicative biophysical envelope for the sites examined in the model.

RESULTS

New Site Records

New site records of the species were limited to captures by the authors from four localities within the Wet Tropics bioregion, with all individuals captured in harp traps:

1. A single female was captured adjacent to Sandy Creek on the Mt Spurgeon Road in the Mt Carbine Tablelands (16028'S, 145012'E) at an elevation of 1130 m on 25 June 1996 (M. Schulz, unpublished record).
2. A single male was captured at Wallaman Falls National Park (18036'S, 145048'E) at an elevation of 640 m on 3 September 1995 (A. Kutt, unpublished record).

Table 2. Bioclimatic profile for M. florium from the Wet Tropics bioregion. Temperatures in OC, all precipitation quantities in mm, slope and aspect in degrees. All biophysical data derived from BIOCLIM (Nix 1986; Hutchinson 1991), except: * - unpublished data provided by S.Turton, M. Hutchinson, A. Accad, W. Sayers, B. Buckley and M. Jessop.

Parameter	Maximum	Minimum	Mean	Standard Deviation
Annual mean temperature	21.50	18.79	19.69	1.02
Maximum temperature of warmest period	33.29	28.90	31.70	1.25
Minimum temperature of coldest period	10.40	7.80	8.57	0.83
Temperature annual range	22.60	19.70	20.35	0.88
Mean temperature wettest quarter	24.60	22.20	22.80	0.82
Mean temperature driest quarter	19.10	16.50	17.65	1.70
Mean temperature warmest quarter	25.20	22.79	23.46	0.82
Mean temperature coldest quarter	17.40	14.20	15.26	1.23
Annual precipitation*	2752	1266	1825	437.7
Precipitation of wettest period	110.00	78.00	92.11	9.69
Precipitation of driest period	16.00	0.00	3.33	6.63
Precipitation seasonality (coefficient of variation)	92.00	68.00	83.11	9.39
Precipitation of wettest quarter*	1427.00	813.00	995.67	190.30
Precipitation of driest quarter *	239.00	76.00	136.33	50.71
Precipitation of warmest quarter	836.00	531.00	731.22	85.12
Precipitation of coldest quarter	329.00	121.00	189.33	68.90

3. One male was trapped adjacent to Taravale Road on the boundary of Mt Zero Holding and Mt Spec State Forest, Paluma Range (19002'S, 146008'E) at an elevation of 875 m on 9 December 1998 (Schulz and Hogan 1998a).
4. One male was trapped adjacent to Clarke Creek in Mt Zero Holding, Paluma Range (19001'S, 146008'E) at an elevation of 880 m on 10 December 1998 (Schulz and Hogan 1998a). This site was situated 0.9 km from locality (3) but has been listed as a separate locality on the basis of habitat type (see below).

Habitat

The majority of records were from a variety of rainforest vegetation associations (Table 1). Two sites were either dominated or had components of sclerophyllous emergents above a rainforest understorey. Site 10 in the Paluma Range was located in Type 14c tall open forest dominated by rose gum *Eucalyptus grandis* and red mahogany *E. resinifera* with a rainforest understorey. Although dominated by simple notophyll vine forest, Site 7 in Koombooloomba State Forest, also included small patches of Type 14c tall *E. grandis* open forest with an understorey of complex notophyll vine forest. Four rainforest sites where *M. florium* were trapped are situated within 100 m of ecotones with open forest types lacking a rainforest understorey (Table 1).

A single locality, Site 11 in Mt Zero Holding, was located in non-rainforest habitat. Vegetation at this site was characterised by Type 14c tall open forest dominated by *E. grandis, E. resinifera* and turpentine *Syncarpia glomulifera* lacking a rainforest understorey. Understorey vegetation in this site consisted of a scattered shrub layer dominated by *Dodonaea triquetra* and hickory wattle *Acacia aulacocarpa*. The ground layer was dominated by a variety of sedges and grasses, including blue flax lily *Dianella caerulea, Digitaria sp., Gahnia aspera, Fimbristylis sp.*, blady grass *Imperata cylindrica*, variable sword sedge *Lepidosperma laterale, Oplismenus aemulus, Panicum effusum* and *Scleria mackaviensis*. The nearest tall open forest with a rainforest understorey to the site was located in a straight-line distance of 420 m and the closest area of rainforest lacking a *Eucalyptus* canopy was 550 m.

Predicted Distribution

The derived bioclimatic envelope indicates that the distribution of *M. florium* encompasses a wide range of temperature and rainfall gradients (Table 2). Actual capture sites and predicted distribution of *M. florium* are presented in Figure 1. Similarity index categories used were 0.9 or higher, since the value of the predictive output of such climatic models is less valid at lower similarity levels (Carpenter *et al.* 1993). Two levels of similarity, which are user-defined, were mapped: 0.9 indicating areas with an average variation in climate values from the known occurrence sites of no more than 10% of the range; and 0.95, being no more than 5% variation. These two levels are presented to identify the most highly similar areas, and so as not to provide an overtly false impression of wide potential distribution, derived from a limited number of locality records.

Areas with a high similarity index generally followed the shape and distribution of upland (>300m) rainforest areas and fauna subregions (Williams 1997), with the Atherton Uplands from Atherton to south of Ravenshoe, identified as being largest in area (Figure 1). More narrow zones of similarity are identified to the north and south, generally associated with locality records: the Finnegan and Carbine Uplands west of Cooktown and Mossman respectively; the Lamb Uplands west of Cairns; the Lee and Kirrima Uplands west of Ingham; and the Spec and Halifax Uplands at Paluma. Discontinuities in this upland distribution pattern occur at the Black Mountain corridor and in the southern Atherton Uplands at the Tully River gorge and the Herbert River gorge.

Small areas of similar habitat are identified in low altitude areas associated with the Bloomfield Lowlands south of Cooktown to the Daintree River, the McAlister Foothills and sites directly around Cairns. In general, the large coastal lowland areas (<300 m) such as the Thornton and Mossman Lowlands (between Daintree and Mossman) and the Cairns-Cardwell and Ingham Lowlands, vary bioclimatically by at least 10% from known trapping localities for *M. florium*, and as such fail to predict the occurrence of this species.

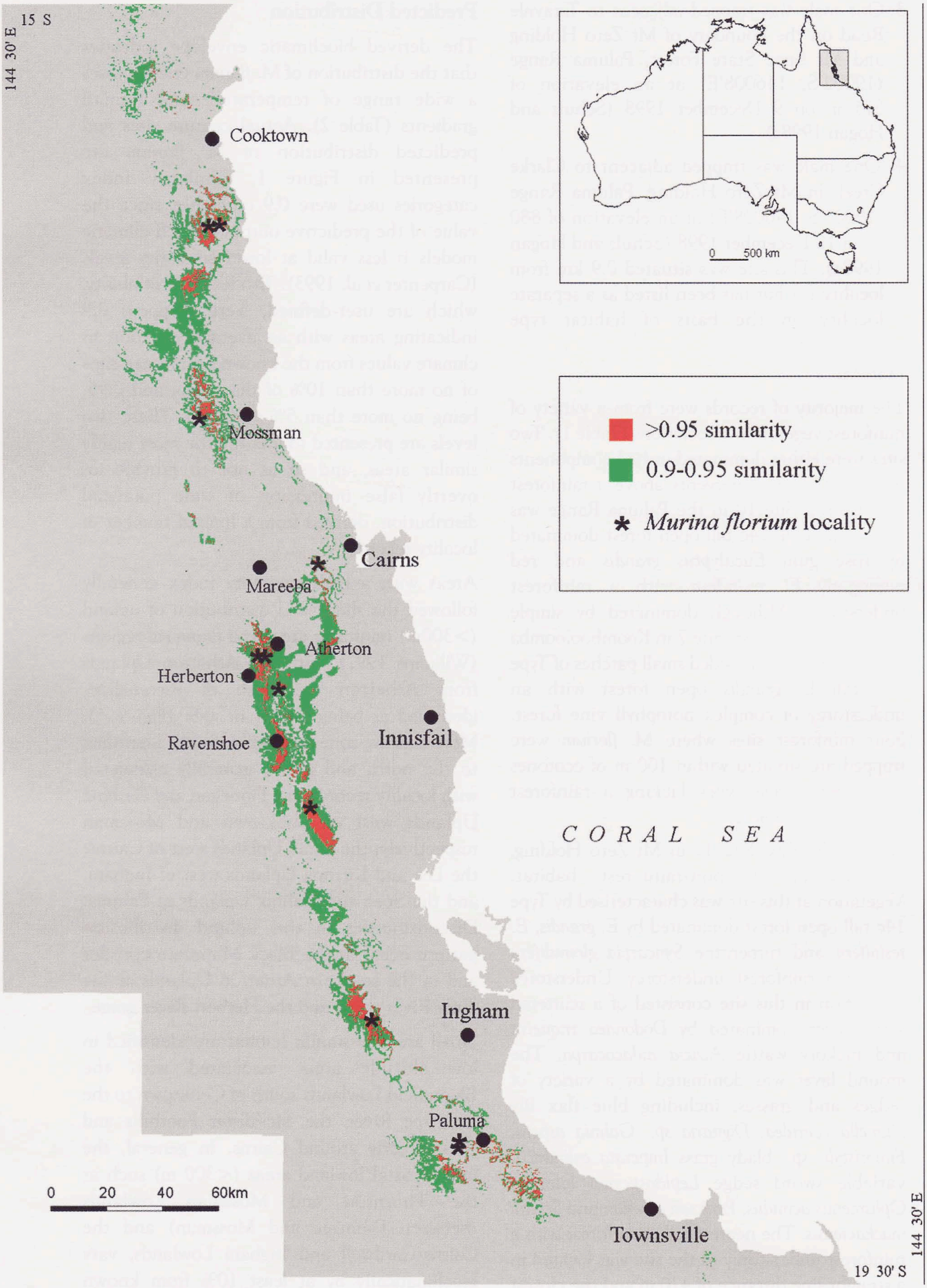
15 S
144 30' E
Cooktown
Mossman
Cairns
Mareeba
Atherton
Herberton
Ravenshoe
Innisfail
Ingham
Paluma
Townsville
CORAL SEA
0 20 40 60km
144 30' E
19 30' S
0 500 km
🟥 >0.95 similarity
🟩 0.9-0.95 similarity
* *Murina florium* locality

Figure 1. Projected DOMAIN distribution of the flute-nosed bat Murina florium in the Wet Tropics of north-eastern Queensland.

DISCUSSION

Distribution of M. *florium* in the Wet Tropics

Patterns of distribution and abundance of Wet Tropics vertebrate fauna have been extensively studied (e.g. Winter *et al.* 1987; Nix and Switzer 1991; Winter 1997). More recent surveys have examined key factors controlling the diversity, endemism and distribution of Wet Tropics vertebrate faunal assemblages and the resultant extant patterns (Williams *et al.* 1996; Williams 1997; Williams and Pearson 1997), though the paucity of distributional and abundance information of the Chiroptera have excluded this group from detailed examination (Williams *et al.* 1996). The pattern of known and predicted M. *florium* distributions matches those seen for a variety of upland Wet Tropics rainforest species; a core abundance in the Atherton Tablelands, with tapering and disjunct distributions to the north and south (Nix and Switzer 1991). Unlike many non-volant mammals, and in particular the rainforest endemic species, the distribution of M. *florium* traverses virtually the entire geographic range of the region. This potentially may be a function of flight and the ability to disperse through non-rainforest habitats.

The additional records of M. *florium* reported here have provided a clearer indication of the extent of the species' distribution within the Wet Tropics. The new record from the Mt Carbine Tablelands represents the northern-most upland locality for the species in the bioregion. New records of M. *florium* from Wallaman Falls and Mt Zero Holding in the Paluma Range extends the southern known range limits of the species by approximately 150 km from the previous most southerly record in Koombooloomba State Forest, south of Ravenshoe (Figure 1). These three records are of particular interest as Lee and Spec Upland regions are considered to be a depauperate fauna outlier of the core Wet Tropics bioregion (Winter *et al.* 1984; Williams *et al.* 1996; Williams 1997). Size and shape of the Wet Tropics subregions, and consequent species extinction as a result of Pleistocene rainforest contractions, have been identified as the primary cause of current non-volant patterns of mammal species richness (Williams 1997). In addition, the Herbert River north of this sub-region is considered a significant discontinuity (topographic and climatic barrier) for the southward distribution of Wet Tropic's fauna (Winter 1997). The pattern of decreased diversity, south of this discontinuity is less significant in birds in comparison to terrestrial mammals, reptiles and amphibians (Williams *et al.* 1996). Such a difference may be a function of higher dispersive ability associated with flight (Williams *et al.* 1996). It is likely that, similar to birds, bats may also be less affected by such barriers.

There is an absence of current M. *florium* records and gaps in the predicted distribution from the large Thornton, Mossman, Cairns-Cardwell and Ingham lowland areas. This may be a function of sampling bias (see below) and limitations of the DOMAIN model. Climate-based distribution models such as DOMAIN are strongly influenced by the locality data input, and the lack of M. *florium* records from the eastern wet tropical escarpments and lowlands may have unduly effected the pattern derived.

Other reasons for a lack of lowland distribution may be hypothesised. Late Quaternary climate change in the wet tropics and associated expansion and contraction of rainforest areas, has both allowed the influx and establishment of New Guinean and south-eastern Australian fauna (Winter 1997), and influenced the current patterns of vertebrate species richness and diversity (Williams 1997). Historically, M. *florium* may have arrived with other New Guinean cool adapted wet tropical species, and being volant, possibly retained a close distributional association with fluctuating upland rainforest areas, a pattern similar to endemic non-volant wet tropical mammals (Williams 1997). Current knowledge of roosting requirements and flight characteristics suggest that M. *florium* has a close association with closed forest (Schulz and Hannah 1996, 1998). In contrast, other non-volant New Guinean invaders (e.g. Striped Possum *Dactylopsila trivirgata*, Long-tailed Pygmy Possum *Cercatetus caudatus*) have become more ubiquitous and widespread in upland and lowland rainforest, and adjacent woodland habitat (Winter 1997). Furthermore, the lowland areas of the Wet Tropics may lack sufficient closed forest habitat for the presence of M. *florium*, apart from riparian or gallery rainforest. A majority of the coastal floodplains of the Johnstone, Tully and Herbert Rivers are open woodland vegetation types (Kemp and Morgan 1998; Kemp et al. 1998), and coupled with recent extensive clearing, may account for an absence or possibly a restricted distribution and low abundance in these areas. Until more detailed primary locality and ecological data for M. *florium* are obtained, information on the full extent of its current extant distribution, and possible causes for any observed pattern, is still speculative.

Distribution: Possible effects of sampling bias

The environmental profile calculated for M. *florium* in the Wet Tropics is limited due to the small number of known localities, and needs to be interpreted with caution. The new capture sites were primarily the result of targeted surveys of specific rainforest areas, predominantly on the western edge of the Wet Tropics, rather than from rigorous stratified sampling throughout the bioregion, incorporating 'non-rainforest' vegetation associations where the species was previously assumed not to occur (e.g. from Richards *et al.* 1982, 1995; Winter 1991).

Sampling strategy and survey timing are likely to be factors contributing to the small number of records of the species. For example, Schulz and Hannah (1998) found that over 80% of M. *florium* captures occurred when a harp trap had been positioned for two or more consecutive nights and 50% of captures were when harp traps had been left *in situ* for three nights or more. Further, trapping conducted during the cooler periods of the year has a lower probability of capturing the species which may be a reflection of M. *florium* foraging for shorter periods in cold weather and ceasing foraging activity when the temperature falls below a critical threshold (Schulz and Hannah 1998).

Small sampling effort or survey timing in rainforest and associated vegetation types may account for the absence of records in the lowlands between Mossman and Townsville. However, relatively high, wet season sampling effort in lowland areas of gallery forest, and complex and mesophyll vine forest at Jourama Falls National Park (46 harp trap-nights and 16 mist-net hours) and Murray Falls Forest Park (18 harp trap-nights), failed to detect M. *florium* (Schulz 1995, Hannah and Schulz 1996). In addition, moderately intensive wet season sampling in a coastal complex of gallery rainforest, dune and beach forest at the Cowley Beach Training Area, near Innisfail (20 harp trap-nights), and the beach forest-mangrove mosaic at Cairns International Airport (16 harp trap-nights, 6 mist-net hours), also failed to detect the species (author A.K. unpubl. data). The above listed examples by no means represent comprehensive sampling, and further survey of lowland vegetation, in particular riparian and remnant rainforest, would be desirable before the presence and absence of M. *florium* in these areas could be more thoroughly assessed.

Habitat of M. *florium*

Ecological information collected on M. *florium* supports the interpretation of current records and predicted distribution of the species being primarily a rainforest inhabitant (Schulz and Hannah 1996, 1998). Trapping records provide only a general indication of habitat use in the Chiroptera. However, the point of capture indicates that trapped individuals were using the airspace within the immediate vicinity of the trap-site for activities such as foraging, commuting to preferred feeding areas or dispersal. The current capture records support the suggestion that M. *florium* is predominantly a rainforest-dwelling species, although the many sites that were located within 100 m of eucalypt forest ecotone or within wet sclerophyll forest with a rainforest sub-storey, imply that this bat may be a 'rainforest-edge' species. However, as many rainforest vegetation associations are nested within a mosaic of emergent, edge and ridgeline eucalypt forest (Webb 1978; Tracey 1982), any predicted habitat specificity may be somewhat artificial. In fact many Wet Tropical endemic rainforest species (e.g. birds, possums), commonly utilise resources in ecotones and neighbouring woodland vegetation (Williams *et al.* 1996; S. Williams pers. comm.). Information collected on roost location from Mt Baldy and Koombooloomba State Forests provides additional evidence to support the importance of rainforest to the species. All 12 diurnal roosts located, including a maternity roost, occurred predominantly in rainforest both with and without sclerophyllous E. *grandis* emergents (Schulz and Hannah 1996, 1998).

Little information is available on foraging habitats utilised by M. *florium*. However, the combination of manoeuvrable flight characteristics (Richards *et al.* 1995, Schulz 1999a, b) and wide-band echolocation calls indicates that this bat is specialised for foraging within a cluttered environment (Aldridge and Rautenbach 1987; Fenton 1990). The very limited information available on habitat used by a single radio-tagged individual in Koombooloomba State Forest and 10 individuals in Mt Baldy State Forest support the conclusions drawn from the ecomorphology of M. *florium*, with all observations confined to rainforest (Schulz and Hannah 1996; Schulz 1999). The characteristics of echolocation calls are important in determining a bat's ability to detect and locate its prey. Species that fly in cluttered microhabitats, such as in the understorey of rainforest typically use ultrasonic signals that are short, low in intensity, high in peak frequency and broadbanded (Fenton 1990). The echolocation calls of M. *florium* conform to these characteristics having a steep almost linear FM sweep in 1.5 to 2 msec with a detection range over very short distances (Richards *et al.* 1995). Manoeuvrability was indicated in M. *florium* by observations of an individual hovering beneath a roost and bats on emergence departing the roost areas by flying between foliage, vines and other cluttered situations in the rainforest understorey (Schulz 1999a, b).

On the basis of ecomorphological characteristics, the record from Mt Zero Holding in a non-rainforest habitat suggests that it may represent commuting or dispersing individuals. It has been suggested that clutter-tolerant species are unlikely to forage in open vegetation types since such habitat may impose a higher cost on these species due to increased energy demands associated with lower insect densities (Aldridge and Rautenbach 1987). However, other species of *Murina* have been observed flying low over the surface of crops and grass while foraging (Nowak 1994). The record of M. *florium* in open forest may indicate that the species displays foraging flexibility. Such flexibility may be in the form of a clutter-tolerant species targeting prey concentrations that form outside cluttered areas, such as the emergence flights of the alates of Ephemeroptera, Isoptera and Hymenoptera. Alternatively, the species may utilise cluttered microhabitat, including within and around dense patches of shrubbery, such as A. *aulacocarpa* and *Dodonaea triquetra* in the Mt Zero site or the tree canopy layer as foraging habitat in open forest.

Conservation and suggestions for future research

Current threats to M. *florium* are poorly understood, but are likely to include clearing and fragmentation of forest, and timber harvesting in *Eucalyptus* forest (Clague et al. 1999). New site records reported in this paper indicate that the species occurs in rainforest, with a high percentage of records adjacent to eucalypt forest/woodland. Additionally, some records were from wet sclerophyll forest with a rainforest understorey, a production forest type subject to timber harvesting outside the Wet Tropics World Heritage Area. The presence of this bat in this latter forest type and in ecotones adjacent to eucalypt forest suggest that the species may be exposed to impact from timber harvesting operations. The effects of these operations and other management related activities such as cattle grazing and current fire regimes on public land managed as National Parks, State Forests and Timber Reserves on the species are currently unknown. There is also the possibility that widespread land clearing in the Wet Tropics has decreased potential available habitat for this species.

Future research on the distribution and habitat preferences of M. *florium* should focus on the use of the distinctive audible call that has an unknown social function (Schulz and Hannah 1996). This call was commonly heard at night in both the Mt Baldy and Koombooloomba State Forest sites where the largest numbers of individuals have been captured (M. Schulz, unpublished records). Audible social calls of a small number of bat species are currently used for identification purposes. For example, the diagnostic call of the eastern tube-nosed bat *Nyctimene robinsoni* is used as an identification tool in south-eastern Queensland and north-eastern New South Wales (e.g. Hall *et al.* 1995; Eyre *et al.* 1998). The social call of M. *florium* was the sole means of recording the species in an assessment of fauna occurring in the Limestone Logging Area within Koombooloomba State Forest (Schulz and Hogan 1998b). The inclusion of M. *florium* based on call identification in this survey is the first time that this call has been used as the primary means of identification. The value of the audible call as an investigative tool was indicated in the Limestone Logging Area where the vocalising individual provided further support of the species occurring in tall open forest lacking a rainforest understorey. This bat was located in forest dominated by E. *resinifera* and S. *glomulifera*, situated 600 m in a straightline from the closest patch of rainforest. The use of the distinctive audible call will provide a useful technique for further sampling the distribution and habitat preferences of the species enabling the predicted distribution of M. *florium* presented in this study to be tested.

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